SP-12S Pro, SEP-12S Plus, SEP-10S Plus

SYRINGE INFUSION PUMPS

SERVICE MANUAL

BS037016EN-P02

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1. INTRODUCTION

◆ This SERVICE MANUAL describes how to check, troubleshoot and repair SP-12S Pro, SEP-12S Plus and SEP-10S Plus syringe infusion pumps. The purpose and maintenance of the pumps are described in the appropriate OPERATING INSTRUCTIONS.

If when repairing your pump you have encountered problems, which you cannot solve, or the pump parameters are changed after the repair, please, in all these cases contact the manufacturer.

NOTE:

The manufacturer's authorized personnel may carry out the technical servicing of the pump only!

2. TECHNICAL DATA

Power supply:
220–230 VAC ±10%, 50/60 Hz, or 115 VAC ±10%, 50/60 Hz, or internal rechargeable battery

Fuses:
T80 mA/L250 V – for 220–230 VAC
T160 mA/L250 V – for 115 VAC

Power consumption:
10 VA (max)

Internal battery:
9.6 V 1300 mAh NiMH battery

Cordless work time:
8 h (minimum) at 5 ml/h infusion rate;
2 h (minimum) at 100 ml/h infusion rate.

Battery recharging time: 24 hours.

Classification: Class II, CF, splash proof.

RS232 (optional)

12 VDC supply connection (optional)

Nurse Call connection (optional)

Operating temperature range:
+5 to +40 °C.

Storage temperature range:
-20 to +40 °C.

Air pressure:
60 to 106 kPa.

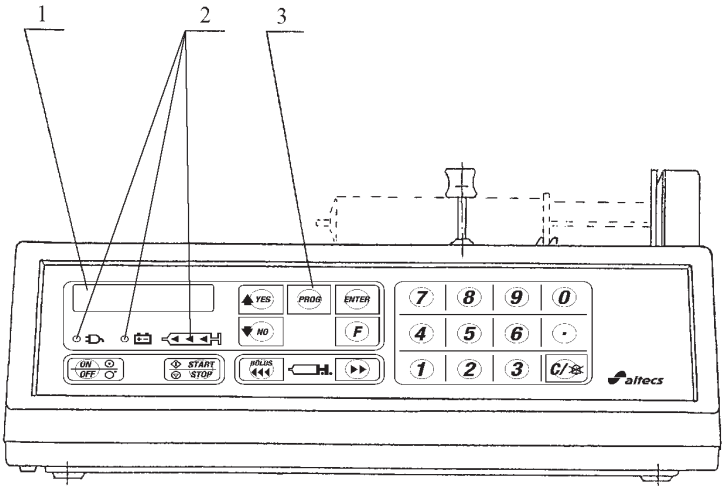
Relative humidity:
90% max., no condensation (operation and storage).

Dimensions:
135 x 305 x 195 mm

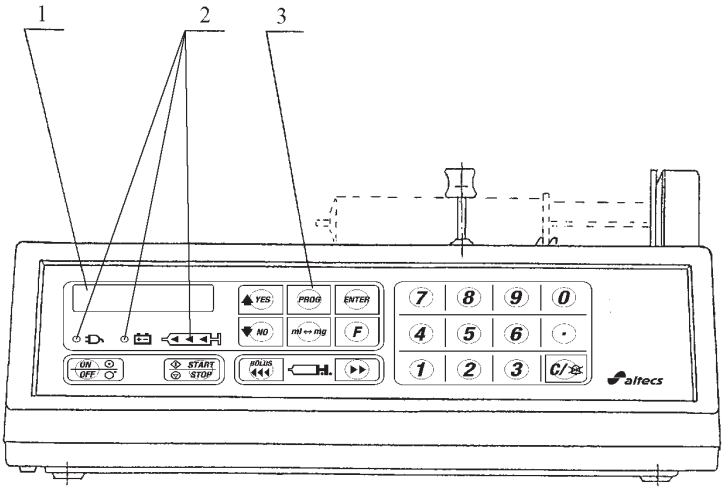
Weight:
2.6 kg.

3. EXTERNAL VIEW

Fig. 1.



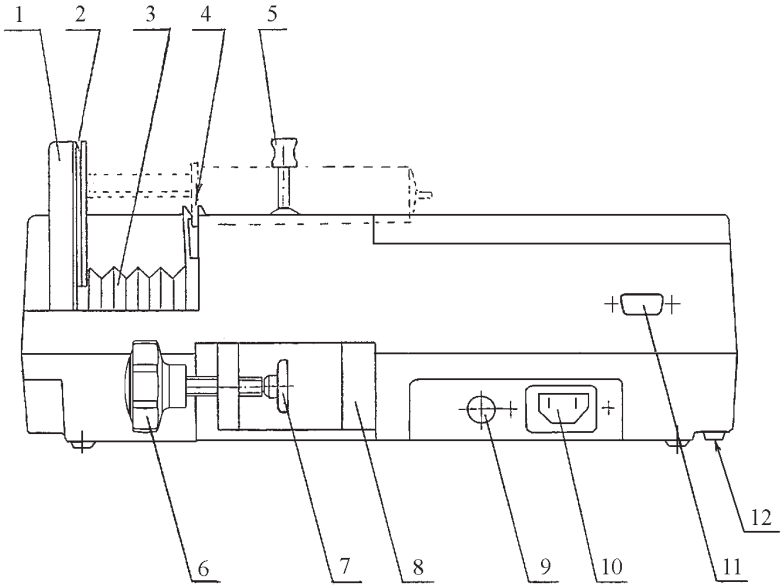
Front view of the pump SEP-10S Plus



Front view of the pumps SP-12S Pro, SEP-12S Plus

1 – display 2 – indicators 3 – keypad

Fig. 2.



Rear view of the pumps SP-12S Pro, SEP-12S Plus and SEP-10S Plus

1 – syringe driver arm
2 – slot for inserting the push-button of the syringe plunger
3 – rubber bellows
4 – slot for inserting the finger grips of the syringe barrel
5 – syringe clamp
6 – handle
7 – cap
8 – mounting pole clamp
9 – fuse holder
10 – mains inlet
*11 – MFC**
*12 – Audio volume control**

* – optional

4. KEYBOARD DESCRIPTION

 – green indicator, indicating pump connected to the AC line 220–230V and battery charging.

 – green LED is on when pump runs on internal battery; flashing if LOW BATTERY alarm condition occurs.

 – during infusion, three yellow LEDs are sequentially flashing. If the rightmost LED is on permanently – the infusion is stopped.

– key to switch the pump on/off; keep it pressed for several seconds in order to switch off.

– key to start/stop the infusion.

– key to move the syringe driver arm rapidly to the left-hand side during syringe insertion or to initiate the Bolus mode; it is also intended for air removal from the extension set after syringe insertion.

 – key to move the syringe driver arm to the right-hand side.

– keys to scroll up/down the list of parameters and syringe brands or answer positively or negatively the dialog questions.

– key to select dimensions of parameters when programming (only in SP-12S Pro and SEP-12S Plus).

– key to program (modify) parameters. Pressing it once more restores previous values.

– key to confirm the selected parameter.

– numerical keys to enter digits of the parameter being programmed.

– key to select additional functions or to review programmed parameters.

– key to cancel the numerical value or the meaning of the parameter or silence the alarm signal. It deletes TOTAL INFUSED and INFUSED DOSE values and clears the numerical value on display when programming.

5. TECHNICAL DESCRIPTION

5.1. PRINCIPLE OF OPERATION

◆ The pump is intended for precise dosing of medicine at the rate programmed by the operator. The speed of syringe driver arm is set by the microcontroller, which evaluates the syringe volume and features of the syringe model. The microcontroller controls the step motor, which transfers movement to the syringe driver arm via the helical gear. The microcontroller monitors also voltage of the internal battery, mains voltage, occlusion pressure, Bolus volume and rate. Data on pump status and programming data are outputted to the alphanumeric 2x16 symbol display. Operation of the microcontroller is monitored by the special circuit (watch-dog), which unconditionally switches off the motor in case of failure of the microcontroller.
In case of mains voltage failure, the pump automatically continues its operation being powered from the internal rechargeable battery and warns the operator on this by means of audible and visual signals.

5.2. ELECTRICAL SCHEMATIC DIAGRAM OF THE PUMP

5.2.1. Principle of operation

◆ The electrical schematic diagram of the pumps are presented in the Annex A, B. The interconnection diagram of the pump is presented in Annex C. Diagrams of the pump are composed of the following main parts:

- power supply;
- keyboard;
- drive;
- syringe size sensor;
- electronic board B7043.

5.2.2. Power supply

- 220-230 VAC (or 115 VAC) voltages via the mains filter MF1 and fuse F1 is fed to the primary winding of the step-down transformer TR1. Voltage from the secondary winding of the transformer TR1 reduced to 10-11 VAC is rectified by the diode bridge D1 and capacitor C1 (11-13,5 VDC) and via the fuse F1(A2) is fed to the remaining part of the circuit. The resistor R1 sets the charging current for the rechargeable batteries GB1, GB2 which shall be in range of (70-130) mA. When the pump is powered from the internal battery, power supply current goes via the diode D2. The fuse F2(A2) protects batteries by limiting charging and load currents. There is fed a signal to the electronic board B7043 via the diode D3 and the resistor R2 informing the pump is powered from the external mains of 50/60 Hz, 220-230 VAC (or 115 VAC). The electronic board B7043 controls the buzzer Z1.

5.2.3. Keyboard

- The keyboard is composed of 21 keys (SEP-10S Plus 20 keys) in form of a matrix having 7 inputs and 3 outputs. Electronic board B7043 performs scanning of the keyboard and reading of information from it. The key ON/OFF controls the circuit of electronic power supply switch located on the electronic board B7043.

5.2.4. Drive

- The stepper motor SM1 rotates the lead screw with a nut on it converting rotating movement of the motor to linear movement of the tube. The tube supported by four guiding bearings is connected to the syringe driver arm. Marginal positions of the tube with syringe driver arm are limited by:
  - limit switch S1 at the right extreme position which is actuated by the end of the tube;

- rotational optical sensor TAX1 at the left extreme position when the tube covers the raster of rotating coupling of the optical sensor TAX1.

In case of occlusion when pressure in the syringe increases to the prohibited level, it stops movement of the syringe driver arm and at the same rotation of the stepper motor SM1.

Rotation of the stepper motor is controlled by the optical sensor TAX1 which reads a signal, reflected from the raster of rotational coupling. This signal is fed to the microcontroller U18 located on the electronic board B7043, and this signal switches on the emergency signal. There is some delay between beginning of occlusion on one hand and stepper motor SM1 stopping and emergency signal actuation on the other hand depending on infusion rate, length, thickness and elasticity of extension tube.

- The pre-alarm switch S2 is activated when the distance between syringe finger flange and syringe thumb rest is equal to 45 mm. When this distance is equal to 27 mm, the end switch S1 is activated, which in this case acts as the second pre-alarm switch. When the pre-alarm switch has been activated, the pump calculates distance to the end of appropriate syringe. Based on this there are calculated and activated the following warning messages:

where X ≤ 5 min., and

- In case of occlusion the stepper motor SM1 executes some number of steps back depending on syringe type. This reduced pressure in the syringe and extension tube and at the same time reduces unwanted Bolus volume injected to the patient when the cause of occlusion is removed.

5.2.5. Syringe size sensor

◆ Syringe size sensor is implemented as a sliding potentiometer R1. Depending on syringe diameter, potentiometer slider position is changed and its output voltage at the same time, which is linearly proportional to the output resistance of the potentiometer R1. This output voltage is fed to the electronic board B7043.

5.3. ELECTRICAL SCHEMATIC DIAGRAM OF ELECTRONIC BOARD B7043

◆ The electrical schematic diagram of electronic board B7043 is shown in the annex C.
It is composed of the following main parts:

- microcontroller circuit;
- display circuit;
- "watch-dog" circuit;
- stabilized power supply;
- electronic power-supply switch circuit;
- syringe size sensor signal processing circuit;
- DAC;
- pulse current stabilizers;
- switches.

5.3.1. Microcontroller circuit

◆ There is used the T89C51RD2 microcontroller U18 having internal RAM of 256 bytes for data, internal flash memory of 64 kB and external EEPROM of 32 kB for software and external time keeper SRAM U14 with clock for log.
The quartz resonator Q2 of 12,288 MHz sets clock frequency for microcontroller. The microcontroller U18 selects addresses of the SRAM U14 (lower addresses from port P0 via register U13, higher addresses from port P2 directly). The microcontroller U18 via port P0 and register U11 generates instructions for step motor control,

writes information to display MD1, writes and reads information to/from SRAM U14, controls the buzzer, LEDs D26, D27, D28 "RUN". Also via port P0 and register U13, it scans the keyboard. Information from the keyboard is read via register U12 to port P0.

- The microcontroller U8 AT89C2051 receives information from the microcontroller U18 T89C51RD2 to its inputs P3.0 and P3.2 on step motor rotation direction, period between steps and power. The restart signal for the microcontroller U8 (pin 1) is generated by means of elements C46 and R51 in time of power switching on. When master "watch-dog" circuit is activated, a high-level signal is applied to the restart input of the microcontroller U8 interrupting its operation.

5.3.2. Display circuit

- Information to display MD1 (addresses and data) is written from the port P0 of microcontroller U18. The resistors R88–R91 sets current via transistor T15 and at that same time current for backlighting LED of display MD1. This current shall be equal to 70 ± 10 mA when backlighting is switched on and 10 ± 5 mA when backlighting is switched off. The backlighting current is controlled by the signal from microcontroller U18 via register U10. Resistor R93 defines brightness of the display MD1.

5.3.3. "Watch-dog" circuit

- The special "Watch-dog" circuit monitors operation of the microcontroller U18. In case of disturbances in microcontroller U18 operation, this circuit prevents functioning of the pump, stops the motor and activates audible alarm. The basis of master "Watch-dog" circuit is monostable multivibrator U5A, U5B and the trigger U3A. They compose the frequency discriminator with pass-band of 500 Hz to 2 kHz.

- The slave watch-dog circuit is composed of elements U17A, D25, C61, C74. When for some reason the pulses cease to arrive to capacitor C61, 0.5 sec later a low-level signal is generated at the output 6 of the Schmitt trigger U17A initiating actuation of the master watch-dog circuit.

5.3.4. Stabilized power supply

- There are used two stabilized +5VDC voltages Vcc1 and Vcc2. The voltage Vcc1 is supplied to the microcontroller U18, "Watch-dog" circuit and electronic power supply switch. When powering of the pump is switched off by means of the key ON/OFF, voltage Vcc1 goes down to 2V (voltage Vcc2 becomes equal to 0V).
  The IC U1 is the voltage stabilizer. The transistor T1 is a current amplifier and the transistor T2 is a power supply switch.
  Adjustable resistor R13 sets threshold for emergency signal actuation on discharge of batteries GB1, GB2 (voltage on pin 7 of the IC U1 shall go down from +5V to 0V when battery voltage drops to 9.2V).
- DC/DC converter U2 generates necessary negative voltage of –(4,7÷5,0)V at its output (pin 5).

5.3.5. Electronic power-supply switch

- When the pump is switched on by pressing the key ON/OFF, there is set at the same time inhibition to switch it off, i.e. the low-level signal is applied to pin 13 of the trigger U3B. This inhibition may be removed either by the microcontroller U18 having received an appropriate request or by the "watch-dog" activated. The microcontroller U18 via the input T0 receives information on depressed key ON/OFF. Then when the key ON/OFF is kept depressed for 3 sec the microcontroller U18 switches off the pump by applying high-level pulse to the pin 10 of the trigger U3B.

Electronic power-supply switch output signals control the power supply stabilizer and switch the microcontroller U18 to mode of low power consumption or to normal mode. These signals via capacitor C67 generate start (reset) pulse for microcontroller U18.

5.3.6. Syringe size sensor signal processing circuit

- The voltage taken from the potentiometer for syringe diameter and proportional to the syringe diameter is fed to ADC U7. Information on syringe diameter in digital form from U7 is transferred via the serial port to the input P1.0 of the microcontroller U18.

5.3.7. DAC (digital to analog converter)

- The DAC is composed of resistor network, amplifier U6A and inverter U6B. Depending on the code at the port P1 of the microcontroller U8, voltage at the output 7 of the operational amplifier U6A is changing in the range 0 to -0.4V. The inverter is based on the operational amplifier U6B and converts this voltage to positive one. The voltage from the output 1 of U4B is fed to two (separate for each phase of the motor) sample-and-hold units for analogous signal, implemented on elements T6, C55 and T7, C57 accordingly. There are generated two independent voltages on capacitors C11, C12 being proportional to currents flowing through motor phases.

5.3.8. Pulse current stabilizers

- The pulse current stabilizer for the 1st phase is composed of elements U15A, T5, R56, D18, D19, L4, R61, R60, and that for the 2nd phase - of elements U15B, T4, R57, D15, D20, L5, R67, R69. Further is described operation of the pulse current stabilizer for the 1st phase only. The voltage from the capacitor C55 is fed to the inverting input 2 of

the comparator U15A. The non-inverting input of the comparator receives the signal equal to voltage drop across the resistors R61, R60 and proportional to current flowing through them. When this voltage is lower than that on the capacitor C55, then transistor T5 becomes open. Then the power source VCC-NS is connected to the inductor L4 and the current through it starts to increase. When voltage drop across resistors R61, R60 exceeds voltage from the capacitor C55, the transistor T5 becomes closed and current through the reactor L4 starts to decrease. The new cycle is started, and its frequency depends on inductance of the reactor L4, phase current value and comparator hysteresis.

5.3.9. Switches

- Currents for both phases flow to the common conductors of motor phase coils via accumulating reactors L4 and L5. Direction of motor rotation is defined by appropriate order of current switching in both phase coils. This switching is implemented by current switches T8, T9 and T10, T13 for the 1st and the 2nd phases accordingly.

6. SETUP MENU

◆ In order to access optional functions or certain parameters, keep the **START/STOP** key in pressed position and switch the pump on by pressing the **ON/OFF** key. When short beep is heard, release the **START/STOP** key, enter appropriate code with the numerical keys and confirm it by pressing the **ENTER** key.
The total list of optional functions/parameters and their access codes are presented in the Table 1:

Table 1

CODE	*NAME*	*DESCRIPTION*	*NOTE*
100	Pump modes		
137	Syringe list		
147	Drug list		
157	DEFAULT GRUG SET	restoring default (manufacturer's) jist of drug	
237	Functions	Configurable functions/parameters	
257	DEFAULT PARAMETERS SET	restoring default (manufacturer's) parameters	
337	LANGUAGE SET: ENGLISH and other	installation of dialog language	
537	SYRINGE SIZE CALIBRATION	to calibrate syringe sensor	for calibration needs spacers: B8640027, B8640027-01, B8640027-02, B8640027-03
547	OCCLUSION CALIBRATION	calibration of occlusion level	
637	DATE, TIME	setting of date and time	

◆ List of optional functions may be reviewed using the scroll keys. If displayed name is marked with the asterisk, it means that function is active. To activate an inactive function press the ENTER key, and the asterisk will appear in front of the item name.
To deactivate a function, press the C key. The asterisk shall disappear.

- To change flow rate upper limit select appropriate item, press the PROG key, enter the new value using the numeric keys and confirm it by pressing the ENTER key.
- To enter a new drug name open the drug list and select the drug name to be replaced by the new one. Press the PROG key, and enter the new drug name using keys in accordance with the table below (e.g. to enter letter Z press the 9 key four times):

Key	1	2	3	4	5	6	7	8	9	0	.	YES	NO, C
Character	1	A,B, C,2	D,E, F, 3	G,H, I, 4	J, K, L, 5	M, N, O, 6	P,Q, R, S, 7	T, U, V, 8	W, X, Y, Z, 9	%, 0, /, -	.	Space	Backspace

Confirm the new drug name by pressing the ENTER key.

NOTES:

1. Entered character can be reset by means of the C or NO keys.
2. Old drug name can be restored by means of the PROG key until new name is confirmed.

- To exit setup menu press the START/STOP key.
- To change date and time settings enter new values when appropriate demand is displayed and press the ENTER key to confirm them and exit setup menu.

ATTENTION !

It is recommended to minimize number of parameters, types of syringes, drug names and other functions leaving only that necessary for work. It will help to avoid errors in parameters programming and thereby decrease patient's risk.

- If the high occlusion level value after actions specified in section 7.5 are performed is beyond specified limits, occlusion level shall be calibrated. For this sake factual value of high occlusion level pressure obtained during testing is entered into pump.
  Typical value for **CORRECT END** is 60 kPa.

7. CHECKING PARAMETERS

7.1. MEANS REQUIRED FOR PARAMETERS CHECKING

◆ Prepare the following means:
- 50 ml BD Plastipak syringe,
- standard 90 cm long extension tube,
- stop-watch,
- glass test-tube with graduation (one point equal to 0.1 ml), 60 ml or more volume,
- pressure gauge with graduation up to 160 kPa, (accuracy 2.5%).

NOTE:

Programming infusion parameters, filling the syringe and extension tube with drug solution, inserting the syringe into the pump and starting infusion are described in the OPERATING INSTRUCTIONS of the pump.

7.2. CHECKING INFUSION VOLUME

◆ Take the 50 ml BD Plastipak syringe with extension tube connected to it and fill it with distilled water up to the point of 55 ml. Insert the syringe into the pump and confirm the 50 ml BD Plastipak syringe.
Program the following infusion parameters:
- infusion rate – 100 ml/h,
- volume limit – 50 ml,
- occlusion pressure level – HIGH.

Expel the air from the extension tube. Insert the free end of the extension tube into the graduated test-tube and start the infusion. When the infusion is finished, the measured volume in the test-tube shall differ from the programmed volume not more than by ± 1 ml (± 2%).

7.3. CHECKING INFUSION RATE

◆ Take the 50 ml BD Plastipak syringe with extension tube connected to it and fill it with distilled water up to the point of 55 ml. Insert the syringe into the pump and confirm the 50 ml BD Plastipak syringe.
Program the following infusion parameters:
- infusion time – 12 min,
- volume limit – 10 ml,
- occlusion pressure level – HIGH.

Expel the air from the extension tube. Insert the free end of the extension tube into the graduated test-tube and start the infusion. Measure infusion time by the stopwatch and record the volume in the test-tube at the end of infusion. Calculate the infusion rate. It shall be 50 ml/h ± 1 ml/h (± 2%).

7.4. CHECKING BOLUS VOLUME

◆ Take the 50 ml BD Plastipak syringe with an extension tube connected to it and fill it with distilled water up to the point 50 ml. Insert the syringe into the pump and confirm the 50 ml BD Plastipak syringe.
Program the following infusion parameters:
- infusion rate – 50 ml/h,
- volume limit – 50 ml,
- bolus rate – 100 ml/h,
- bolus dose – 20 ml,
- occlusion pressure level – HIGH.

Expel the air from the extension tube. Insert the free end of the extension tube into the graduated test-tube and start the infusion. Record the volume delivered into the test-tube and starts the Bolus mode. Record the volume in the test-tube at the end of the Bolus cycle.
The difference of these two volumes shall be 20 ml ± 0.4 ml (± 2%).

7.5. CHECKING OCCLUSION PRESSURE

◆ Take the 50 ml BD Plastipak syringe with an extension tube connected to it and fill it with distilled water up to the point of 30 ml. Insert the syringe into the pump and confirm the 50 ml BD Plastipak syringe.
Program the following infusion parameters:

- infusion rate – 50 ml/h,
- volume limit – 30 ml,
- occlusion pressure level – LOW.

Connect the pressure gauge to the free end of the extension tube. Start the infusion. As soon as the audible alarm is activated and there is displayed the message

```
OCCLUSION!!!
```

the pressure gauge shall read the pressure of (30 or 40)* kPa ± 15 kPa.

Press the key **C**. Reprogram the occlusion pressure to MEDIUM. Start again the infusion. As soon as the audible alarm is activated and there is displayed the message

```
OCCLUSION!!!
```

the pressure gauge shall read the pressure of 60 kPa* ±15 kPa or 80 kPa* ± 20 kPa.

Press the key **C**. Reprogram the occlusion pressure to HIGH. Start again the infusion. As soon as the audible alarm is activated and there is displayed the message

```
OCCLUSION!!!
```

the pressure gauge shall read the pressure of 90 kPa* ± 20 kPa or 120 kPa* ± 25 kPa.

NOTE:
If measured values of pump parameters are out of ranges permitted, contact the Manufacturer.

* *depends on the installed occlusion presure set (for SP-12S Pro only).*

8. CHECKING ALARM SIGNALS

◆ Alarm signals and their causes are listed in the Table.

No.	*Message in display*	*Cause*
1.	OCCLUSION!!!	The movement of the syringe driver arm is stopped by increased pressure in the syringe.
2.	OCCLUSION or END	The syringe driver arm stopped because the syringe plunger reached the end of the syringe barrel or an occlusion happened.
3.	NO MAINS!!! Check power cord	No mains voltage. The pump is powered from the internal battery.
4.	LOW BATTERY	Low voltage of internal battery. There are left from several minutes (at high infusion rates) to several tens of minutes (at low infusion rates) to the full discharge.
5.	VERY LOW BATTERY	Internal battery is fully discharged.
6.	X min. PREALARM!	Not more than 5 min. left to the end of infusion.
7.	END of INFUSION!	Infusion of a programmed volume is completed
8.	KOR X.X ml/h	1. Infusion was stopped and not resumed in 2 minutes. 2. Infusion is finished, but new infusion isn't programmed or a syringe isn't changed or the pump isn't switched off. 3. Syringe is empty and not replaced.
9.	SYRINGE EMPTY!	Syringe is empty.
10.	CLAMP OPENED!	Clamp is lifted during infusion
11.	ILLEGAL SYRINGE! Change SYRINGE	Syringe diameter does not comply with any syringe installed.
12.	ERROR XXX!	Pump failure (see ANNEX G)
13.	ATTENTION! 2 min INACTIVE	The pump was left for 2 min with no action.
14.	STANDBY TIME ELAPSED	Preset standby time elapsed

All alarm signals are accompanied by the audible alarm. Alarm signals listed in the Table are checked in the following ways:

- 1. Take a 50 ml BD Plastipak syringe with extension tube and fill it with distilled water up to point of 30 ml. Insert the syringe into the pump and confirm the 50 ml BD Plastipak syringe.
  Program the following infusion parameters:
  - infusion rate – 100 ml/h,
  - volume limit – 30 ml,
  - occlusion pressure level – HIGH.

  Connect the pressure gauge to the free end of the extension tube. Start the infusion. When the pressure gauge shows the pressure 90 kPa* ± 20 kPa or 120 kPa* ± 25 kPa, there shall be displayed the message

  OCCLUSION!!!

  accompanied by the audible alarm.

- 2. Take a 50 ml BD Plastipak syringe and pull its plunger out to point of 5 ml (may be without water). Insert the syringe into the pump and confirm the 50 ml BD Plastipak syringe. Program that same infusion parameters as in clause 1. Start the infusion. When the syringe plunger reaches the end of the syringe, there shall be displayed the message

  OCCLUSION or END

  accompanied by the audible alarm.

- 3. Insert a 50 ml BD Plastipak syringe into the pump and confirm it.
  Program the same infusion parameters as in clause 1.

* *depends on the installed occlusion presure set (for SP-12S Pro only).*

Start the infusion. Disconnect the mains cord. There shall be heard the audible alarm and there shall be displayed the message

In spite of this, the pump shall continue to work.

◆ 4. Take a 50 ml BD Plastipak syringe and pull its plunger out to point of 60 ml (may be without water). Insert a 50ml BD Plastipak syringe into the pump and confirm it. Program the following infusion parameters:

- infusion rate – 100 ml/h,
- volume limit – 0 (no limit),
- occlusion pressure level – HIGH.

Disconnect the mains cord. Start the infusion and record the time. Each time the syringe is empty, replace it (pull its plunger to point of 60 ml) as described in the OPERATING INSTRUCTIONS of the pump and re-start the infusion.

Not earlier than 1 hour later* (in case the internal battery of the pump was charged for 24 hours or more and there isn't defined any other time value in the OPERATING INSTRUCTIONS) there shall be heard the audible alarm and there shall be displayed the message

◆ 5. Checking of this alarm signal shall be carried out immediately after the "Low Battery" checks. Continue the procedure described in step 4 and measure the time interval between the displayed messages

* *In case the pump was in use for more than 2 years, this time may be shorter.*

and

```
VERY LOW BATTERY
```

The latter one accompanied by the audible alarm shall appear approximately in 10 minutes. Reconnect the pump to the mains. The green indicator shall glow.

◆ 6. Take a 50 ml BD Plastipak syringe and pull its plunger out to point of 50 ml (may be without water). Insert a 50 ml BD Plastipak syringe into the pump and confirm it. Program the following infusion parameters:

- infusion time – 6 min.,
- volume limit – 10 ml,
- occlusion pressure level – HIGH.

Start the infusion. Soon the audible alarm shall be heard and there shall be displayed the message

```
5 min. PREALARM!
```

◆ 7. Checking of this alarm signal shall be carried out immediately after the "5min. PREALARM" checks. Continue the procedure described in step 6.
5 min later there shall be displayed the message

```
END of INFUSION!
  KOR X.X ml/h
```

◆ 8. Don't switch off the pump after the check of step 7. Press the C key. There shall be displayed the message

```
END of INFUSION!
  KOR X.X ml/h
```

Press the PROG key and restart the infusion with the parameters set in step 6. Press the START/STOP key. 2 minutes later there shall be heard the audible alarm and there shall be displayed the message

```
STOP X.X ml
KOR X.X ml/h
```

- 9. Take a 50 ml BD Plastipak syringe and pull its plunger out to point of 20 ml (may be without water). Insert a 50 ml BD Plastipak syringe into the pump and confirm it. Program that same infusion parameters as in clause 1. Start the infusion. When there is left about 2 mm to the end of the syringe, there shall be displayed the message

```
SYRINGE EMPTY!
 KOR X.X ml/h
```

- 10. Take a 50 ml BD Plastipak syringe and pull its plunger out to point of 20 ml (may be without water). Insert a 50 ml BD Plastipak syringe into the pump and confirm it. Program that same infusion parameters as in clause 1. Start the infusion. Lift the syringe clamp. Infusion stops, the audible alarm shall be heard and there shall be displayed the message

```
CLAMP OPENED!
```

- 11. Insert 50 ml BD Plastipak syringe into the pump. Lift slowly the syringe clamp until the following message is displayed

```
ILLEGAL SYRINGE!
 Change SYRINGE
```

- 12 alarm signal shall be left not checked because it is difficult to simulate such a situation without damaging the pump.

- 13. Insert a 50 ml BD Plastipak syringe into the pump and confirm it. Leave the pump for 2 min with no action

(no pressing of any key), the audible signal is activated and the following message is displayed:

◆ 14. In the STOP mode press the ENTER key. Set STANDBY time value of 1 min and wait. After 1 min delay an audible alarm shall be initiated together with the message

9. TROUBLESHOOTING

All failures are listed in the Table:

No	*SYMPTOM*	*CAUSE*	*CORRECTIVE ACTIONS*
1	Message in the display "NO MAINS!!! Check power cord" although the pump is connected to the mains (the green indicator ⏚ isn't glowing).	1. External fuses are blown. 2. Faulty mains cord. 3. Faulty supply unit.	1. Check the external fuse and replace with identical one, if required. In case it blown again, consult the Manufacturer. 2. Check the mains cord and replace it, if necessary. 3. Check and replace if necessary the supply unit as described in section 10.14.
2	Short cordless work time or no cordless work at all.	1. Fuse F2 is blown in the supply unit. 2. Decreased capacity of the battery.	1. Open the pump as described in section 10.1. Check and replace the fuse with identical one. In case it is blown again, consult the Manufacturer. 2. Connect the pump to the mains for 24 hours in order to charge the internal battery. Disassemble the pump as pointed out in section 10.1. connect the resistor of 20 Ω/10 W to the battery and measure discharge time to the moment the battery voltage drops to 8V. In case this time is shorter than 2 hours (for 1300 mAh capacity battery), replace the battery as pointed out in section 10.2.
3	Rubber bellows cracked.	Rubber ageing. Impermissible chemical substances were used for disinfecting and cleaning.	Replace the rubber bellows as described in sections 10.1 and 10.3.
4	Without syringe, the syringe driver arm doesn't move when pressing the <, >keys.	1. Faulty optical sensor (Fig. 4 pos. 6) or dirty raster in the coupling (Fig. 4 pos. 4).	1. Disassemble the pump as described in section 10.1 leaving the power connector P1 connected. Clean the

No	*SYMPTOM*	*CAUSE*	*CORRECTIVE ACTIONS*
			coupling raster with a piece of soft cloth. Switch on the pump pressing the ON/OFF key. By means of an oscilloscope observe the signal at TP17 in the electronic board B7043 (rotate the coupling slowly by hand). The low level of the signal shall be not more than 1 V and the high level – not less than 3 V during the full revolution of the motor. Otherwise adjust R83 potentiometer or replace the optical sensor (section 10.4).
		2. Broken connecting wires to the stepper motor.	2. Disconnect the connector P1 of the step motor from the electronic board B7043 and check the wires to the step motor for continuity according to the electrical schematic diagram by means of an ohmmeter. If the wires are broken, resolder them. Re-connect the motor connector to the electronic board B7043.
5	In the syringe insertion mode, the syringe driver arm stops with noise when it reaches its right hand side position.	Faulty end switch S1 (Fig. 4 pos. 11).	Check the end switch and replace, if required, as described in the sections 10.1 and 10.5.
6	The pump doesn't display the messages "X min. PREALARM!" and "SYRINGE EMPTY!" although the syringe is filled with more than 50% of its nominal volume.	Faulty pre-alarm switch S2 (Fig. 4 pos. 8).	Check the pre-alarm switch and replace, if required, as described in the sections 10.1 and 10.6.

No	*SYMPTOM*	*CAUSE*	*CORRECTIVE ACTIONS*
7	Although the syringe is inserted, there is displayed the message INCORRECT INSERTION!	Syringe sensor S3 is faulty	Disassemble the pump as described in the section 10.1. Replace the syringe sensor as described in the section 10.7.
8	When a syringe is inserted, a wrong syringe size is displayed, or there is a message ILLEGAL SYRINGE! CHANGE SYRINGE	Faulty syringe size sensor (Fig. 4 pos. 3).	Calibrate syringe sensor (see section 6) or replace it (if calibration was not successful) as described in the sections 10.1 and 10.11.
9	One or several keys fail to operate.	Faulty keys.	Check and replace the keyboard, if required, as described in sections 10.1 and 10.9.
10	Audible alarm of the pump fails to operate.	Faulty buzzer Z1 in the power supply.	Check the buzzer and replace, if required, as described in the sections 10.1 and 10.12.
11	The keyboard scratched, discolored or detached.	Impermissible chemical substances were used for disinfecting and cleaning.	Replace the keyboard as described in the sections 10.1 and 10.9.
12	The pump fails to operate when switched on with ON/OFF key. No message or the message "ERROR XXX" is displayed. Audible alarm is activated.	Faulty electronic board B7043.	Replace the electronic board B7043 as described in the sections 10.1 and 10.8 (see also Annex F).
13	Indicator glows, but the pump fails to operate.	Fuse F1 blown in the supply unit (Fig.2. pos.8).	Open the pump as described in section 10.1. Check the fuse and replace it with identical one, if required. In case it is blown again, consult the Manufacturer.
14	When fixing the pump to a stand, the stand surface is damaged	The plastic cap (Fig. 2 pos. 4) of the cross knob is cracked.	Remove the cross knob of the mounting clamp rotating it counterclockwise until the cap falls down. Rotate the cross knob clockwise with the cylinder of 20mm x 20mm inserted and pressing the new cap between the cross knob

No	*SYMPTOM*	*CAUSE*	*CORRECTIVE ACTIONS*
			screw and the cylinder until the cap seats on the screw.
15	Burned and cracked power supply inlet	The power supply inlet was flushed with liquid and after connection to the mains 220-230 VAC there has occurred short connection.	Disassemble the pump as described in the section 10.1. Replace the power supply inlet as described in the section 10.13.

10. PUMP REPAIR

10.1. DISASSEMBLING THE PUMP (FIG. 1, ANNEX B)

◆ The syringe driver arm shall be moved to its end right hand side extreme position.
Remove six screws (6) located of the pump base. Carefully lift the pump housing and disconnect the supply unit connector P4 (Fig. 2 pos. 9), buzzer connector P5 (Fig. 2 pos. 16) from the electronic board B7043.

10.2. REPLACING INTERNAL BATTERY (FIG. 2, ANNEX B)

◆ Disassemble the pump according to section 10.1. Remove screws (13) fastening the battery cover (14). Disconnect connectors P13, P14 (11) from the supply unit. Install new battery and reconnect connectors P13, P14 (11). Fix the battery cover with screws (13) and reassemble the pump in the reverse order to section 10.1.

10.3. REPLACING RUBBER BELLOWS (FIG. 3)

◆ Remove screw (4) and cover (1). Remove three screws (2) fastening the plate (3) to the tube (10) and remove the plate. Remove screws (11). Remove the rubber bellows (6) and the support (5) from the tube (10).
The new bellows (6) is inserted with its narrower end towards the notch on the tube (10). Spread the silicon sealer on the housing-side of the support (5) and install the support in such a way as to clamp the end of the rubber bellows (6) between the support and the housing (7). Replace the screws (11).
Replace and fasten the plate (3) to the end of the tube (10) with screws (2) clamping the end of the rubber bellows (6). Fasten the cover (1) with the screw (4).

10.4. REPLACING OPTICAL SENSOR TAX1 (FIG. 4)

◆ Disassemble the pump according to the section 10.1. Remove the screw (5) and then remove the optical sensor (6). Note the order of conductor connection and unsolder them. Re-solder the conductors to the new optical sensor (6) in the same order. Pull insulation tubes onto the soldering places. Spread an universal glue onto the optical sensor (6). Fasten the optical sensor (6) by means of the screw (5) so as to maintain the distance between the optical sensor (6) and the coupling (4) equal to 4 ± 0.1 mm. Reassemble the pump in reverse order to the section 10.1.

10.5. REPLACING END SWITCH S1 (FIG. 4)

◆ Disassemble the pump according to the section 10.1. Unsolder two conductors from the end switch (11). Replace the end switch (11) and re-solder the conductors to the same terminals. Pull insulation tubes onto the soldering places. Reassemble the pump in reverse order to the section 10.1.

10.6. REPLACING PRE-ALARM SWITCH S2 (FIG. 4)

◆ Disassemble the pump according to the section 10.1. Unsolder two conductors from the pre-alarm switch (8). Replace the pre-alarm switch (8) and re-solder the conductors to the same terminals. Pull insulation tubes onto the soldering places. Fasten the pre-alarm switch (8) in such a position as to be activated when the distance between the housing surface supporting finger flanges of the syringe and the syringe driver arm surface supporting thumb rest of the syringe is equal to 45 mm. Reassemble the pump in reverse order to the section 10.1.

10.7. REPLACING SYRINGE SENSOR S3 (FIG. 1)

◆ Remove the screw (4) and the cover (1) (see Fig. 3). Disconnect the flexible cable (5) from the connector (4). Remove the syringe sensor (3) with its connector (4). Glue the new syringe sensor (3) with its connector (4) on the same place at the same depth. Connect the flexible cable (5) to the connector (4). Fasten the cover (1) with the screw (4) (see Fig.3).

10.8. REPLACING ELECTRONIC BOARD B7043 (FIG. 4, ANNEX C, E)

◆ Disassemble the pump according to the section 10.1. Remove four screws (10). Disconnect step motor connector P1 from electronic board B7043. Disconnect syringe sensor connector P2, sensors connector P3, MFC (multifunctional connector) connector P6, syringe size sensor connector P8 and keyboard connector J1 from the electronic board B7043 and carefully take out the electronic board B7043. Install the new electronic board B7043, reconnect all connectors in reverse order. Reinstall four screws (10). Reassemble the pump in reverse order to the section 10.1.

10.9. REPLACING KEYBOARD (FIG. 1)

◆ Disassemble the pump according to the section 10.1. Detach the old keyboard (1). Disconnect keyboard (1) connector from the electronic board B7043 (2).
Glue the new keyboard (1) taking openings for the display and for LEDs as a reference. Glue from the left to the right pressing the keyboard (1) with a piece of soft clothes. Reconnect keyboard (1) connector to the electronic board B7043 (2). Reassemble the pump in reverse order to the section 10.1.

10.10. REPLACING MICROCONTROLLER (ANNEX D)

◆ Disassemble the pump according to the section 10.1. Note the orientation of the key on the body of microcontroller U18 on the electronic board B7043. By means of the special tool lift carefully the microcontroller U18 out from its socket on the electronic board B7043.
Insert the microcontroller into the socket on the electronic board B7043 so as to have the same orientation of the key of its body as it was on the old microcontroller. Reassemble the pump in reverse order to the section 10.1.

10.11. REPLACING SYRINGE SIZE SENSOR (FIG. 4)

◆ Disassemble the pump according to the section 10.1. Remove the screw (8) and remove the syringe clamp (9) (see Fig. 3). Disconnect the syringe size sensor (3) connector P8 from electronic board B7043 (9). Remove two screws (1) and lift the syringe size sensor (3) with other parts. Loosen two screws (2) and pull out the syringe size sensor (3). Install, fasten and reconnect the new syringe size sensor (3) executing above-described actions in reverse order. Reassemble the pump in reverse order to the section 10.1. Perform syringe size calibration (see Chapter 6)

10.12. REPLACING BUZZER UNIT (FIG. 2)

◆ Disassemble the pump according to the section 10.1. Detach buzer unit (17) (potentiometer and buzer) from the housing. Glue the new buzer unit to the housing in the same location. Glue potentiometer using thermoglue.
Reassemble the pump in reverse order to the section 10.1.

10.13. REPLACING POWER SUPPLY INLET (FIG. 2)

Disassemble the pump according to the section 10.1. Unsolder wires from power supply inlet (1). Remove two screws (2) and remove the power supply inlet (1). Install the new power supply inlet (1) and re-solder wires to it executing above-described actions in reverse order. Push insulating tubes onto soldering places. Re-assemble the pump in reverse order to section 10.1.

10.14. REPLACING SUPPLY UNIT (FIG. 2)

◆ Disassemble the pump according to the section 10.1. Disconnect connectors P13, P14 (11) and P11, P12 (6) from supply unit (7). Remove four screws (10). Remove the supply unit (7). Install the new supply unit (7) and re-connect connectors executing above-described actions in reverse order. Re-assemble the pump in reverse order to section 10.1.

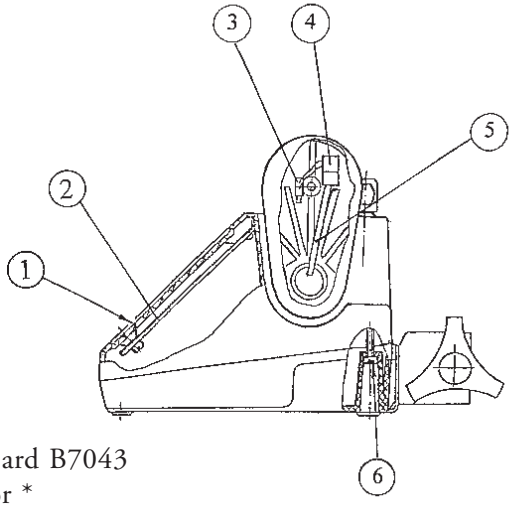


Fig.1

1. Keyboard
2. Electronic board B7043
3. Syringe sensor *
4. Connector *
5. Flexible cable *
6. Screws M4

** – optional*

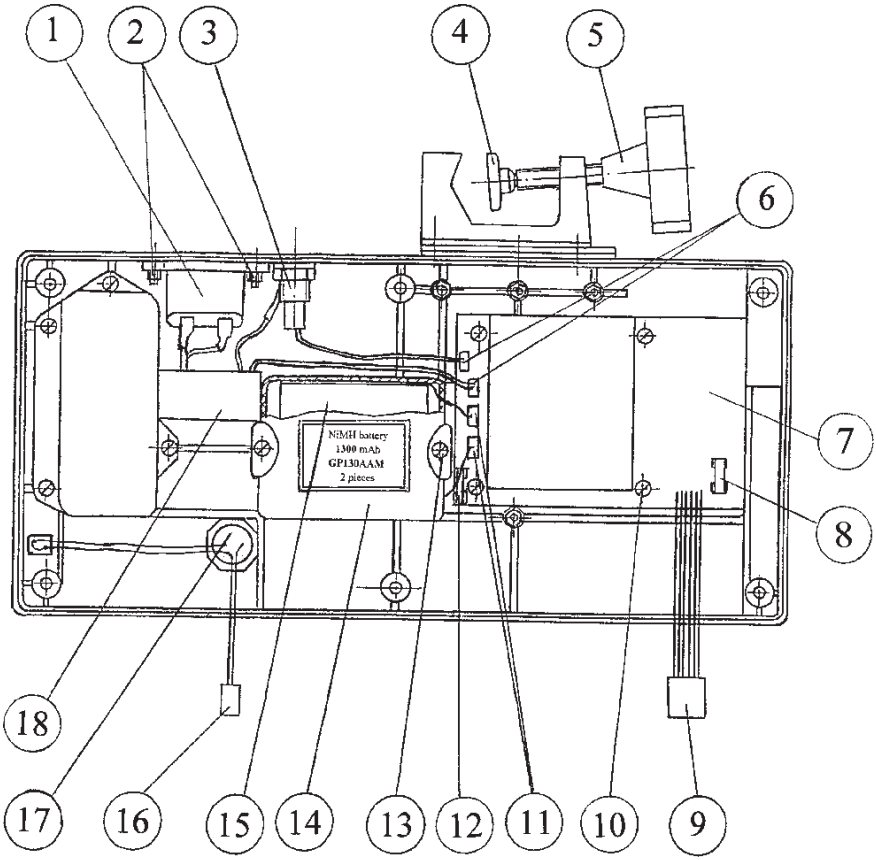


Fig.2

1. Power supply inlet
2. Screw M3x10 with nuts M3
3. Fuse unit with fuse T80mA
4. Plastic cap
5. Cross knob
6. Mains connector
7. Supply unit
8. Fuse T1A
9. Supply unit connector
10. Screws ∅ 3x6,5
11. Battery connector
12. Battery fuse
13. Screw ∅ 3x10
14. Cover
15. Battery
16. Buzzer connector
17. Buzzer
18. Filter unit

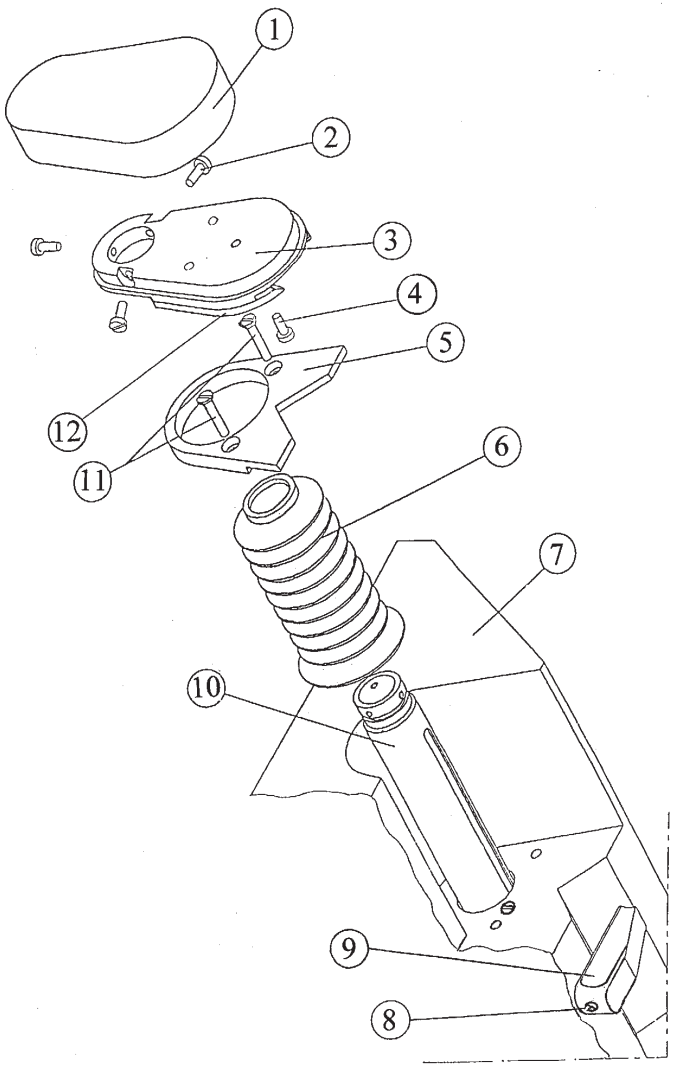


Fig.3

1. Cover
2. Screw M3x8
3. Plate 172
4. Screw ∅ 3x10
5. Support
6. Rubber bellows
7. Housing
8. Screw M2,5x12
9. Syringe clamp
10. Tube
11. Screws M3x16
12. Plate 146

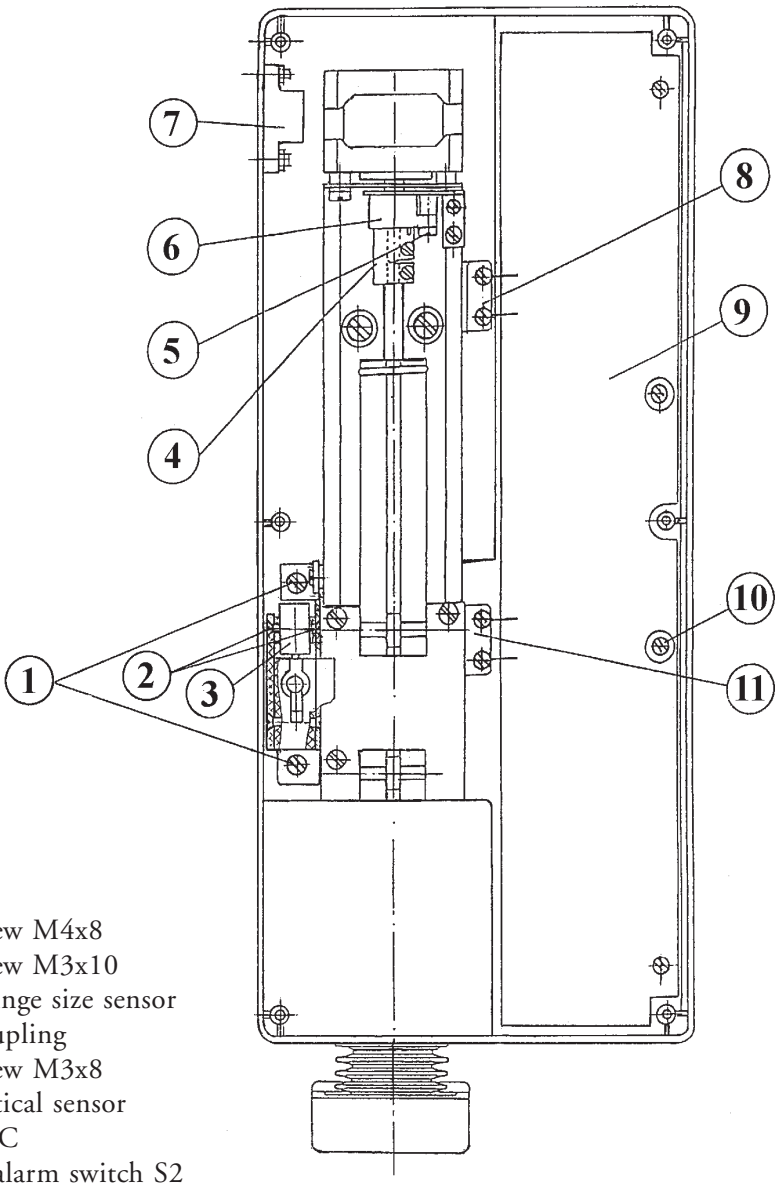
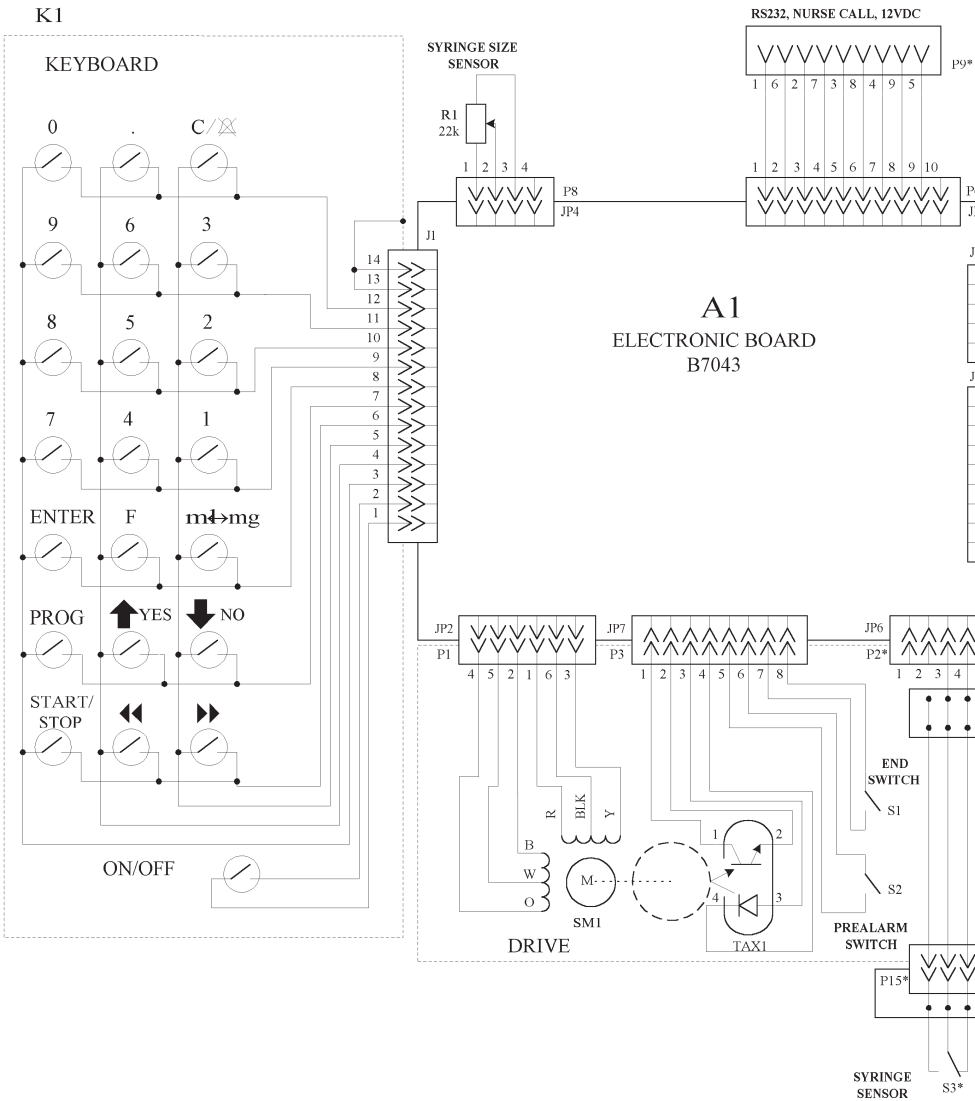


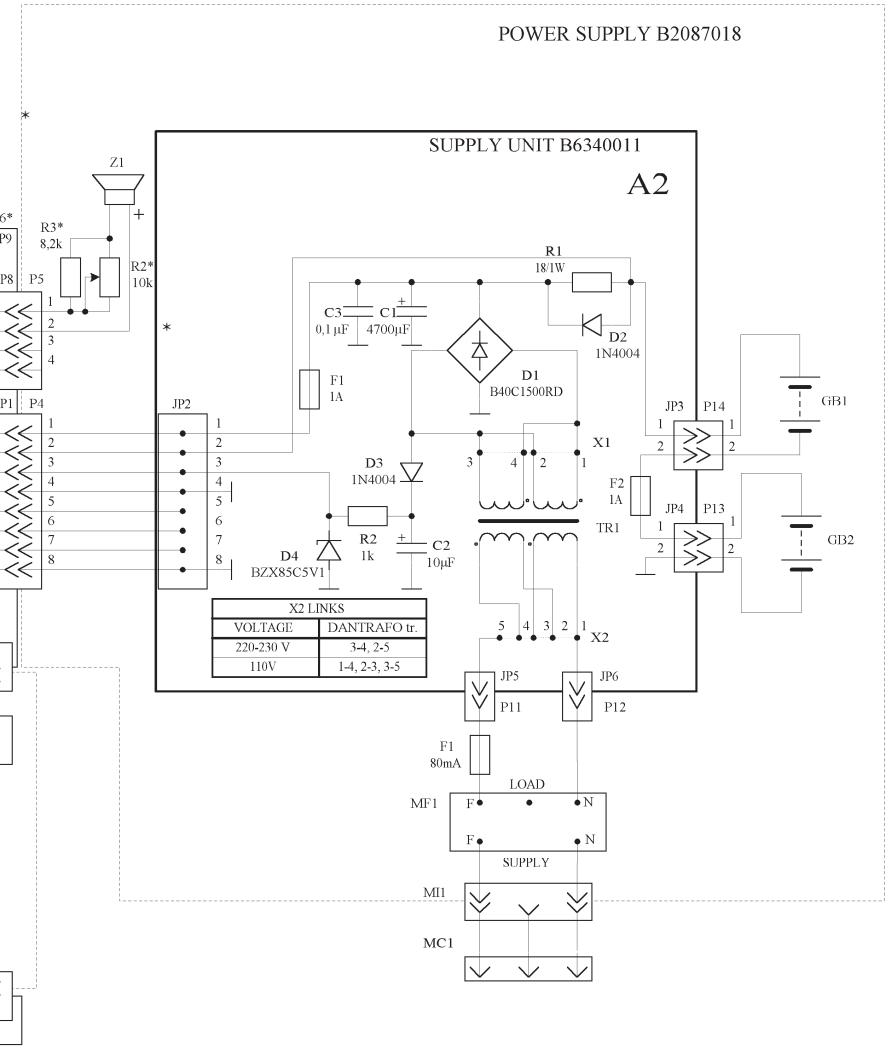
Fig.4

1. Screw M4x8
2. Screw M3x10
3. Syringe size sensor
4. Coupling
5. Screw M3x8
6. Optical sensor
7. MFC
8. Prealarm switch S2
9. Electronic board B7043
10. Screws ∅ 3x6,5
11. End switch S1

ANNEX A

ELECTRICAL SCHEMATIC DIAGRAM OF THE PUMPS SP-12S Pro and SEP-12S Plus

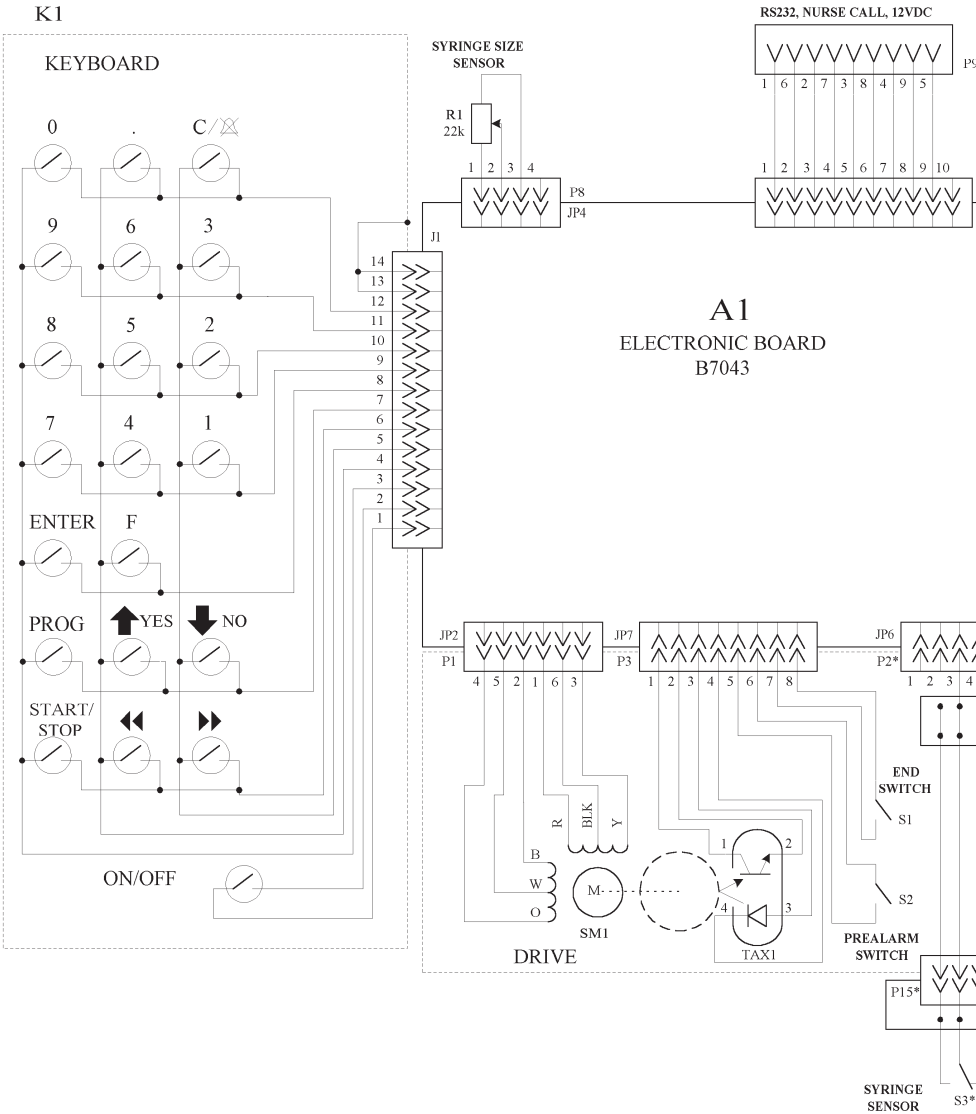


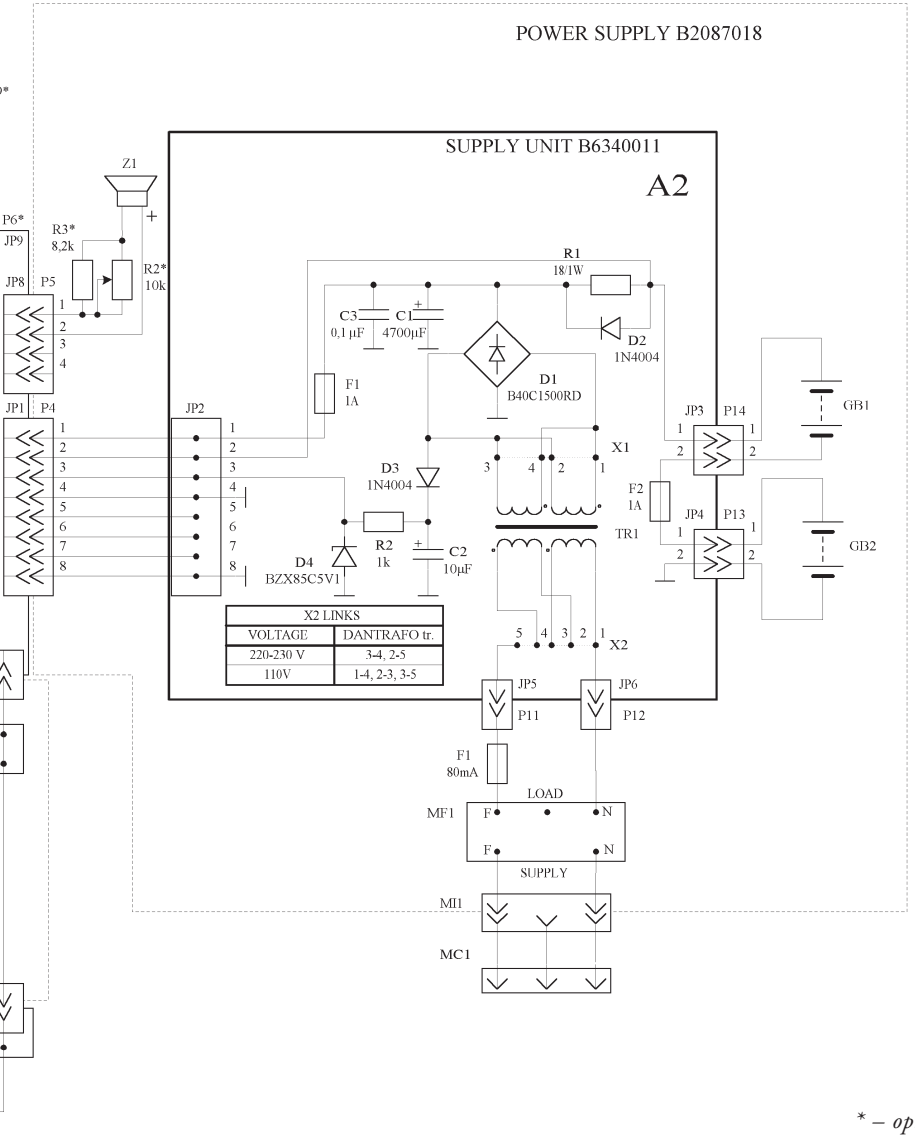

POWER SUPPLY B2087018
SUPPLY UNIT B6340011
A2
Z1
R3*
8,2k
R2*
10k
P8
P5
P9
P1
P4
JP2
F1
1A
C3
0,1 µF
C1
4700µF
R1
18/1W
D2
1N4004
D1
B40C1500RD
D3
1N4004
D4
BZX85C5V1
R2
1k
C2
10µF
X1
TR1
F2
1A
JP3
P14
JP4
P13
GB1
GB2
X2 LINKS
VOLTAGE
DANTRAFO tr.
220-230 V
3-4, 2-5
110V
1-4, 2-3, 3-5
X2
JP5
P11
JP6
P12
F1
80mA
LOAD
MF1
F
N
SUPPLY
MI1
MC1

** – optional*

ANNEX B

ELECTRICAL SCHEMATIC DIAGRAM OF THE PUMP SEP-10S Plus

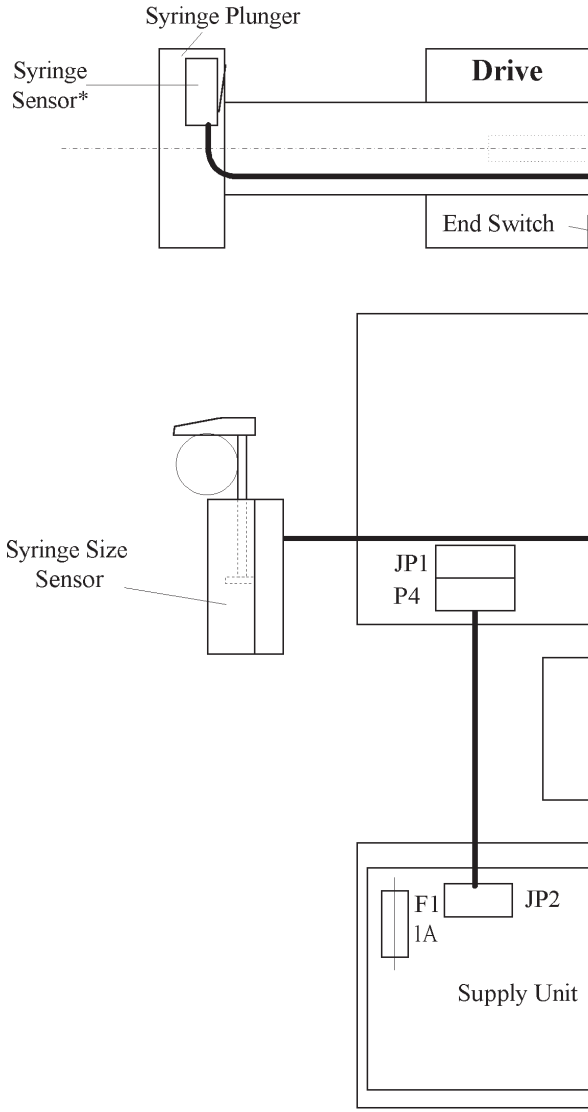


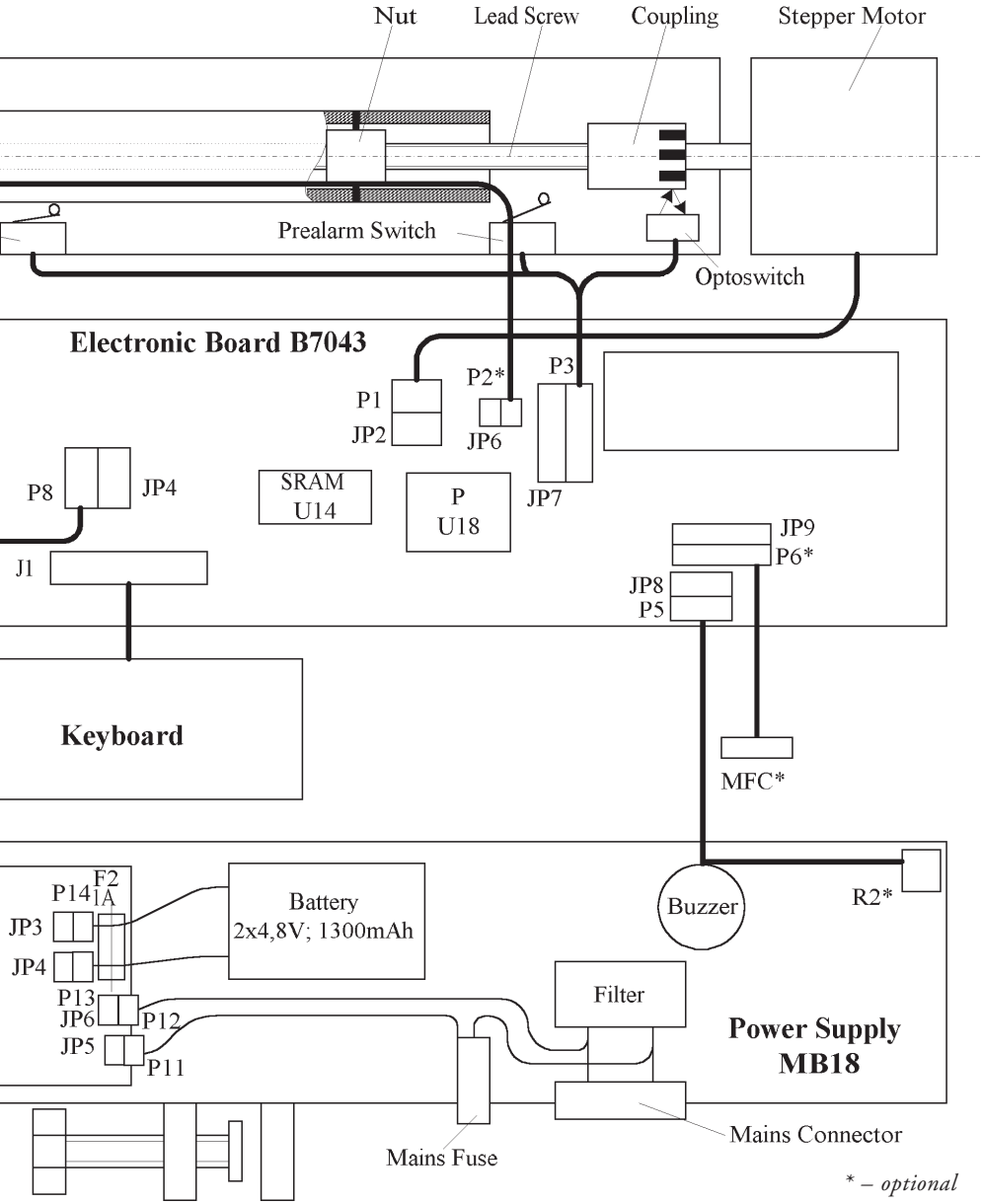

POWER SUPPLY B2087018
SUPPLY UNIT B6340011
A2
Z1
P6*
JP9
R3*
8,2k
R2*
10k
JP8
P5
JP1
P4
JP2
C3
0,1 µF
C1
4700µF
R1
18/1W
D2
1N4004
D1
B40C1500RD
F1
1A
D3
1N4004
D4
BZX85C5V1
R2
1k
C2
10µF
X1
TR1
F2
1A
JP3
P14
JP4
P13
GB1
GB2
X2 LINKS
VOLTAGE
DANTRAFO tr.
220-230 V
3-4, 2-5
110V
1-4, 2-3, 3-5
JP5
P11
JP6
P12
F1
80mA
LOAD
MF1
F
N
SUPPLY
MI1
MC1

** – optional*

ANNEX C

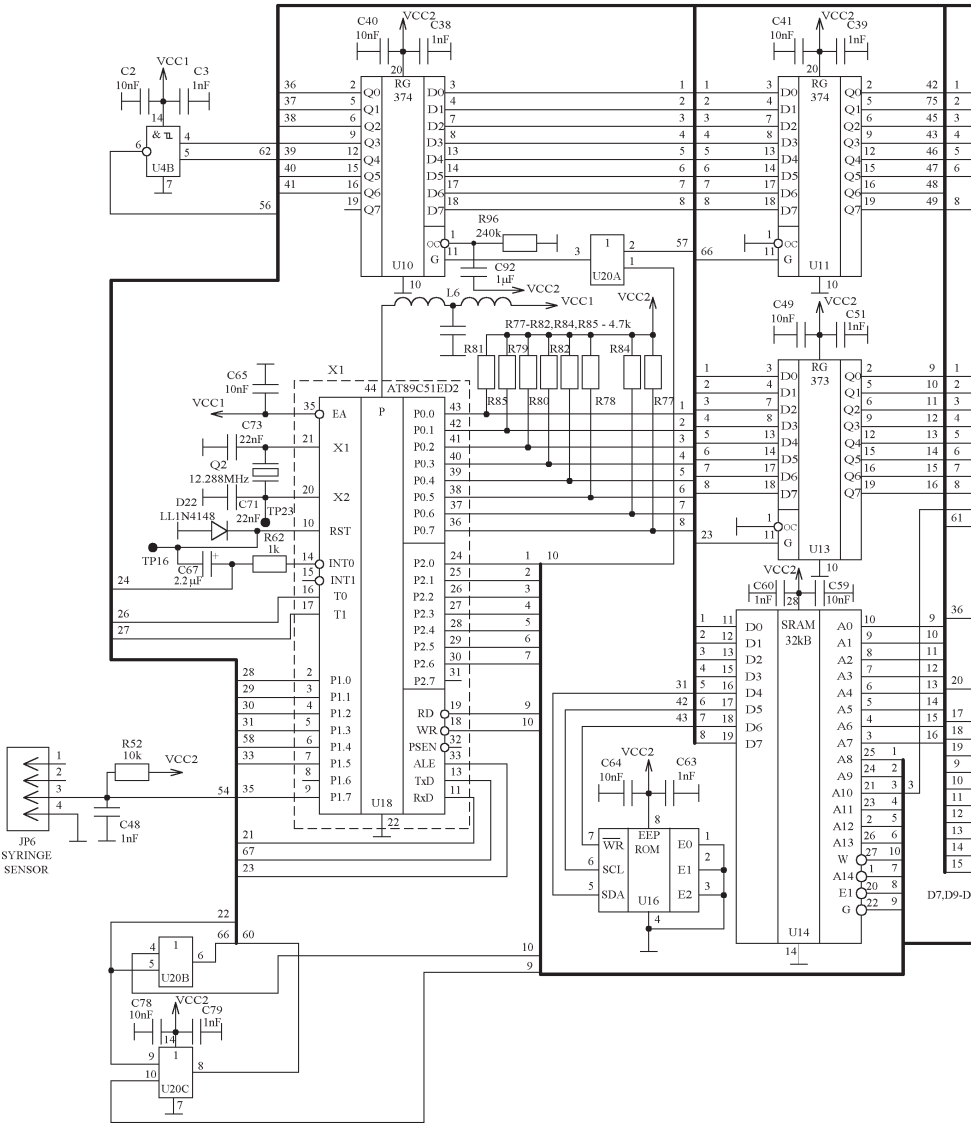
INTERCONNECTION DIAGRAM OF THE PUMPS

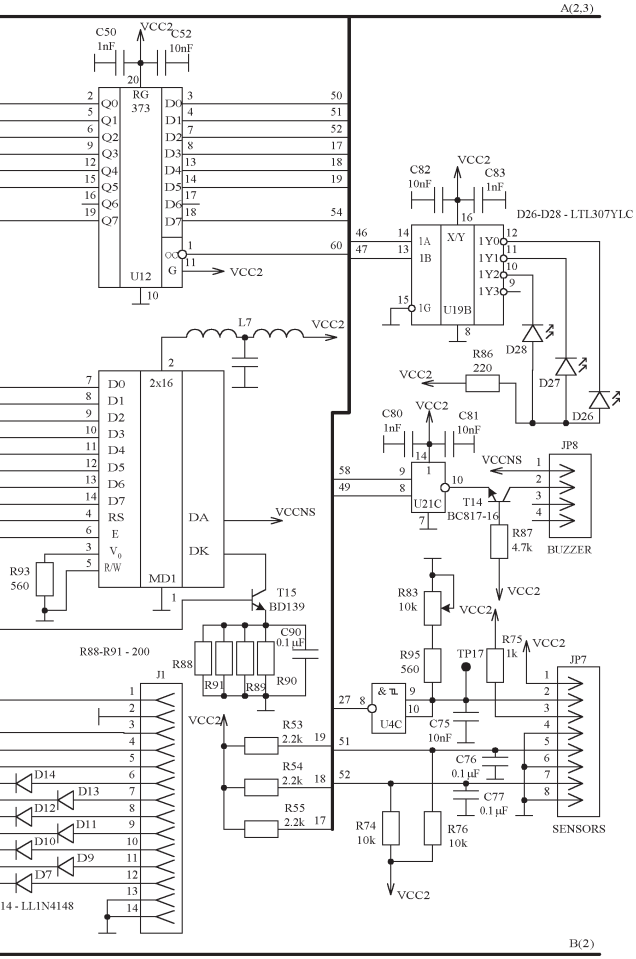



Nut
Lead Screw
Coupling
Stepper Motor
Prealarm Switch
Optoswitch
Electronic Board B7043
P1
JP2
P2*
JP6
P3
JP7
P8
JP4
SRAM
U14
P
U18
J1
JP9
P6*
JP8
P5
Keyboard
MFC*
F2
1A
P14
JP3
JP4
Battery
2x4,8V; 1300mAh
Buzzer
R2*
P13
JP6
P12
JP5
P11
Filter
Power Supply
MB18
Mains Fuse
Mains Connector
* – optional

ANNEX D

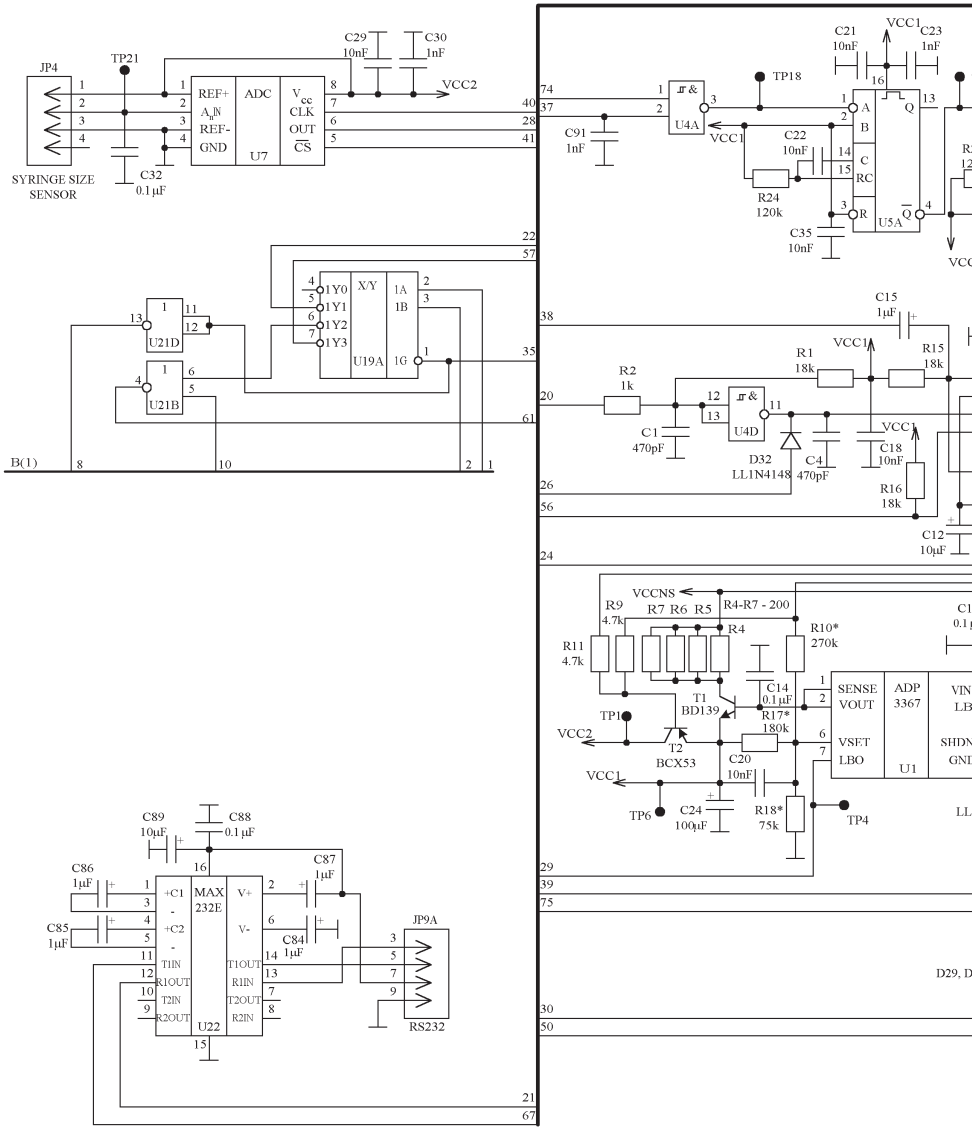
ELECTRICAL SCHEMATIC DIAGRAM OF ELECTRONIC BOARD B7043

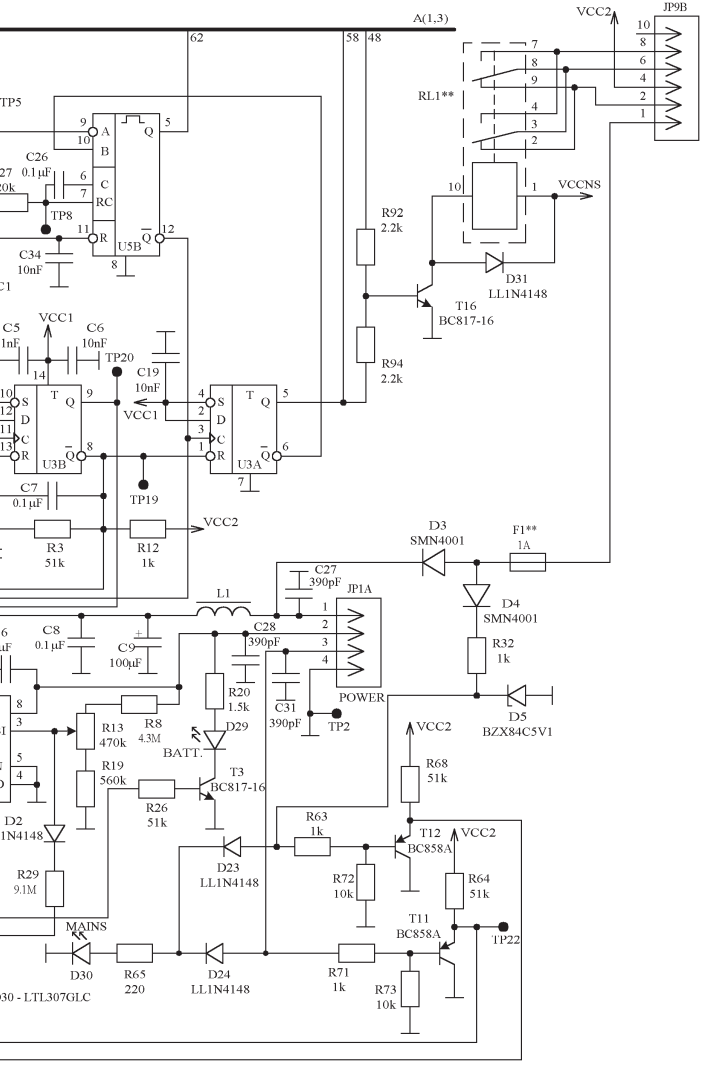



A(2,3)
C50
1nF
VCC2
C52
10nF
RG
373
U12
VCC2
C82
10nF
C83
1nF
D26-D28 - LTL307YLC
U19B
D28
D27
D26
R86
220
L7
VCC2
C80
1nF
C81
10nF
JP8
VCCNS
BUZZER
U21C
T14
BC817-16
R87
4.7k
2x16
DA
DK
VCCNS
MD1
T15
BD139
R93
560
R83
10k
R95
560
TP17
R75
1k
JP7
SENSORS
R88-R91 - 200
R88
R91
R89
R90
C90
0.1 µF
J1
U4C
C75
10nF
C76
0.1 µF
C77
0.1 µF
R53
2.2k
R54
2.2k
R55
2.2k
R74
10k
R76
10k
D14
D13
D12
D11
D10
D9
D7
14 - LL1N4148
B(2)

ANNEX D

ELECTRICAL SCHEMATIC DIAGRAM OF ELECTRONIC BOARD B7043 (continue)

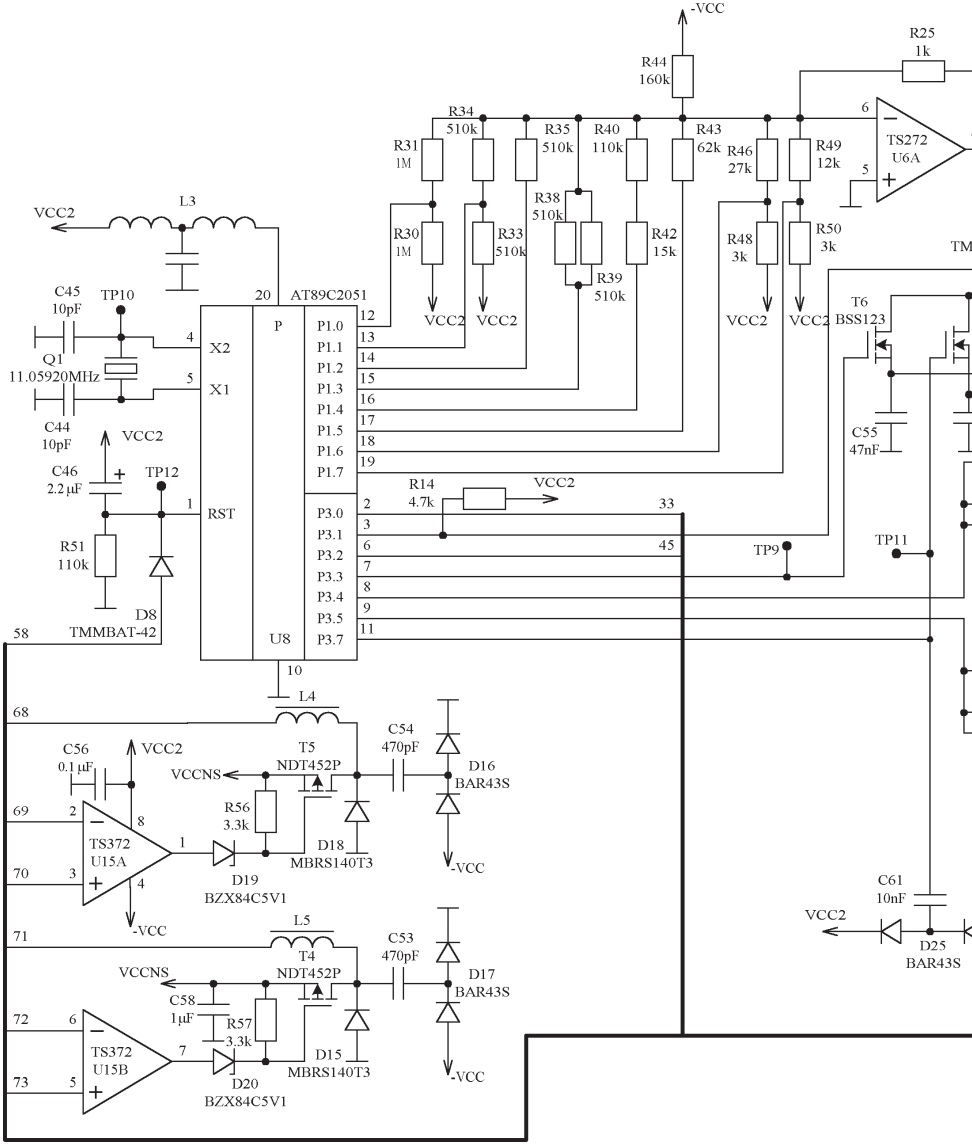


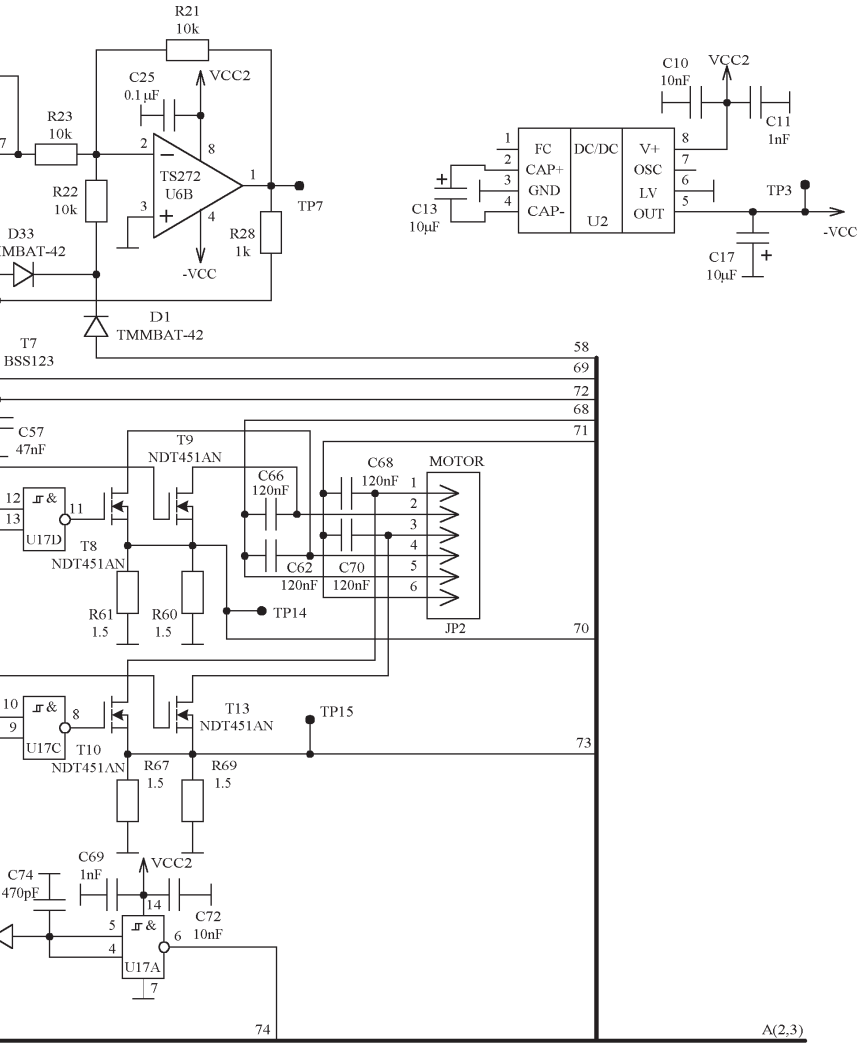


* - 1% rezistors.
** - optional

ANNEX D

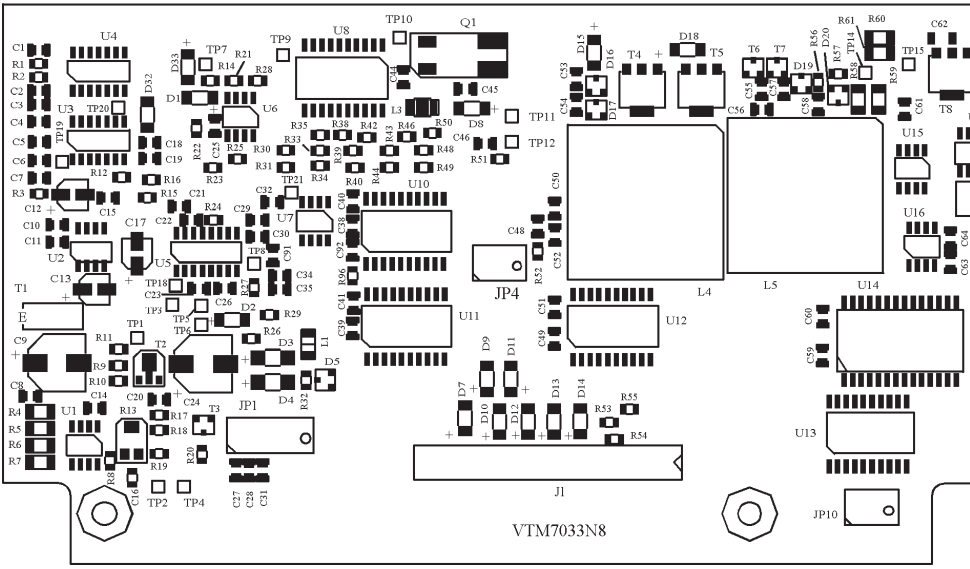
ELECTRICAL SCHEMATIC DIAGRAM OF ELECTRONIC BOARD B7043 (continue)

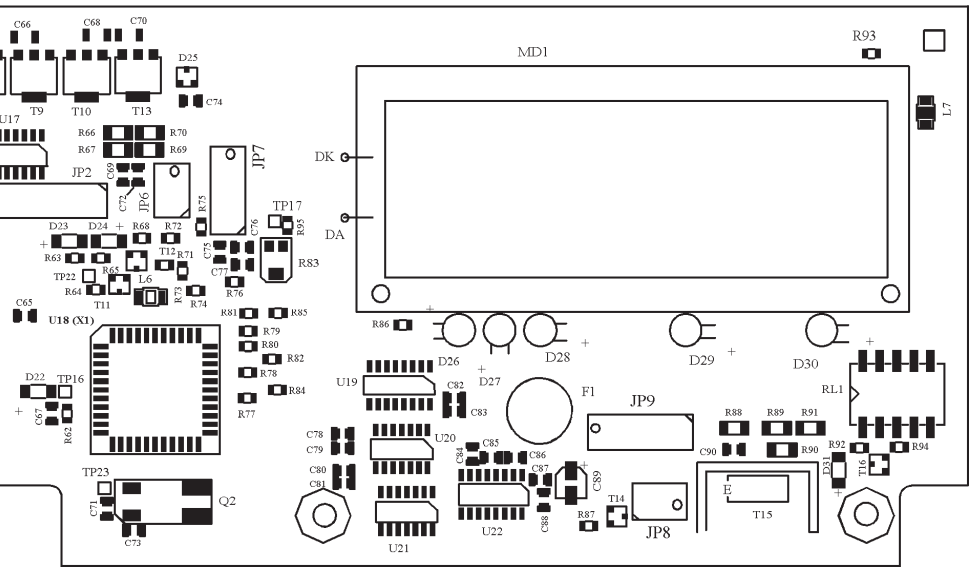



R21
10k
C25
0.1µF
VCC2
R23
10k
R22
10k
TS272
U6B
TP7
D33
TMBAT-42
R28
1k
-VCC
D1
TMMBAT-42
T7
BSS123
C10
10nF
VCC2
C11
1nF
FC
CAP+
GND
CAP-
DC/DC
U2
V+
OSC
LV
OUT
C13
10µF
TP3
-VCC
C17
10µF
58
69
72
68
71
C57
47nF
T9
NDT451AN
C66
120nF
C68
120nF
MOTOR
U17D
T8
NDT451AN
C62
120nF
C70
120nF
R61
1.5
R60
1.5
TP14
JP2
70
U17C
T10
NDT451AN
T13
NDT451AN
TP15
73
R67
1.5
R69
1.5
C69
1nF
VCC2
C74
470pF
C72
10nF
U17A
74
A(2,3)

ANNEX E

ASSEMBLY DRAWING OF ELECTRONIC BOARD B7043

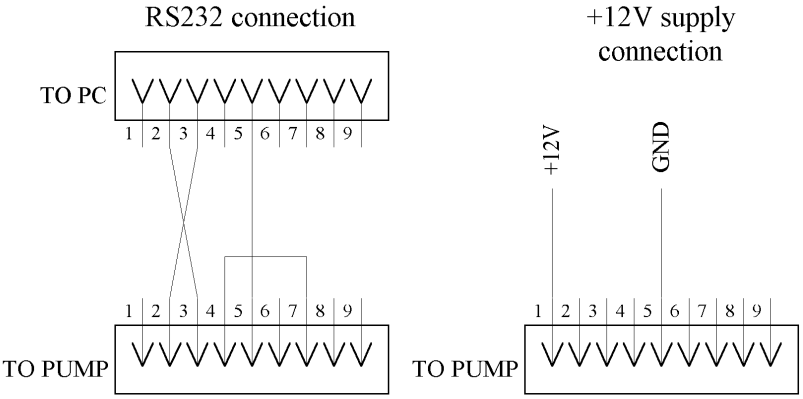


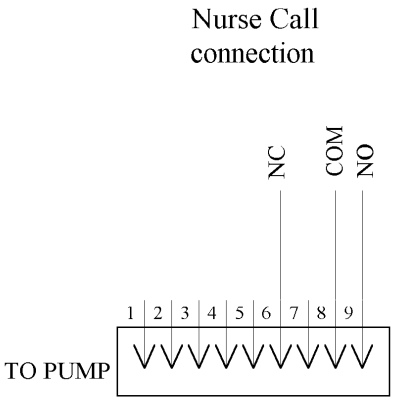

C66
C68
C70
D25
C74
T9
T10
T13
U17
R66
R67
R70
R69
JP2
C69
C72
JP6
R75
JP7
TP17
R95
C76
D23
D24
R68
R72
R63
R65
T12
R71
C75
C77
R83
TP22
L6
R64
T11
R73
R74
R76
C65
U18 (X1)
R81
R85
R79
R80
R82
R78
R84
R77
D22
TP16
C67
R62
TP23
C71
Q2
C73
DK
DA
MD1
R93
L7
R86
D26
D27
D28
D29
D30
U19
C82
C83
F1
JP9
RL1
R88
R89
R91
C90
R90
R92
R94
D31
T16
C78
C79
U20
C85
C84
C86
C87
C80
C81
C89
T14
R87
JP8
T15
U21
U22
C88

** – optional*

ANNEX F

DRAWING OF CABLES FOR MULTIFUNCTIONAL CONNECTOR (MFC)*





Connection data:
Ground (GND)
Normally Closed (NC)
Common (COM)
Normally Open (NO)

** – optional*

NOTE:

Use standard D Type – 9 pin connectors.

ANNEX G

DESCRIPTION OF ERRORS

All errors are listed in the Table:

Error	*DESCRIPTION*	*CORRECTIVE ACTIONS*
ERROR 001	Cannot read data from external EEPROM	Recycle power
ERROR 002	Cannot write data to internal EEPROM	Configure Setup menu repeatedly (see Chapter 6)
ERROR 004	Occlusion koeff. settings failed	Calibrate occlusion level (see Chapter 6)
ERROR 005	Language setting failed	Select language (see Chapter 6)
ERROR 006	Incorrect program CRC	Consult the manufacturer
ERROR 007	Syringe size sensor calibration failed	Calibrate syringe size sensor (see Chapter 6)
ERROR 008	Date and time setting failed	Set date and time (see Chapter 6)
ERROR 009	Drug set failed	Restore default drug set (see Chapter 6)
ERROR 011	Incorrect external EEPROM CRC	Consult the manufacturer
ERROR 013	Watchdog activated	Consult the manufacturer
ERROR 016	Data of current syringe failed	Recycle power
ERROR 017	SRAM test failed	Recycle power
ERROR 018	Incorrect program CRC (fast test)	Consult the manufacturer
ERROR 019	Incorrect Bootloader CRC	Consult the manufacturer

NOTE:

When eliminated fault repeats consult the manufacturer.

ANNEX H

PREVENTIVE MAINTENANCE CHECKLIST

Serial number .....

Service Manual section	Parameter	Value
7.2	Infusion volume accuracy	%
7.3	Infusion rate accuracy	%
7.4	Bolus volume accuracy	%
7.5	Occlusion pressure accuracy: Low Med High	kPa kPa kPa

Service Manual section	Alarm signal	Comment
8(1)	OCCLUSION!!!	
8(2)	OCCLUSION or END	
8(3)	NO MAINS!!! Check power cord	
8(4)	LOW BATTERY	
8(5)	VERY LOW BATTERY	
8(6)	X min. PREALARM!	
8(7)	END of INFUSION	
8(8)	KOR X.X ml/h	
8(9)	SYRINGE EMPTY!	
8(10)	CLAMP OPENED!	
8(11)	ILLEGAL SYRINGE! Change SYRINGE!	
8(13)	ATTENTION! 2 min INACTIVE	
8(14)	STANDBY TIME ELAPSED	

Pump owner/ward .....
Tests performed by (name, surname, signature) .....
Tests performed (date) .....

ANNEX I

COMPONENT LIST

No	*Description*	*Code*
1	Battery GB1, GB2	B6640004
2	Rubber bellows	B8703002
3	Optical sensor TAX1	V5440101
4	End S1 and prealarm S2 switch	V5500900
5	Syringe sensor S3	B6660016
6	Electronic board B7043	B3087043
7	Keyboard	V6675033 (for SEP-10S Plus) V6675034 (for SP-12S Pro) V6675042 (for SEP-12S Plus)
8	Microcontroller U18	B6270010
9	Syringe size sensor	B6666002
10	Buzzer unit Z1	B6710005 (with volume control) B6710006 (without volume control)
11	Power supply inlet	V5520180
12	Supply unit	B6340011
13	Fuse T80 mA F1 Fuse T160 mA F1	V5501002 (for 230 VAC mains) V5501000 (for 115 VAC mains)
14	Fuse T1A F1, F2(A2)	V5501020
15	Plastic cap	B8123009
16	Filter unit	B6730006
17	Cross knob	B6370007
18	Display MD1	V5500442
19	LED yellow D26, D27, D28	V5430100
20	LED green D29, D30	V5430200
21	Mains cable	V5570010 (European style)
22	Syringe clamp	B8127002
23	Plate 172	B8600172
24	Plate 146	B8600146
25	Support	B8126028 (without tooth) B8126046 (with tooth)

ANNEX J

ACCESSORIES

Part number	*Description*
B8640027	Spacer syringe sizing 1
B8640027-01	Spacer syringe sizing 2
B8640027-02	Spacer syringe sizing 3
B8640027-03	Spacer syringe sizing 4

ANNEX K

COMMUNICATION PROTOCOL TECHNICAL DESCRIPTION

- Communication protocol is used for downloading "Event Log" from the syringe pump in response to commands from a computer.
- The protocol uses a variation of the HDLC format for data transfer. Following format is used to transfer commands from computer to the syringe pump:

BYTES	CODE	DESCRIPTION
1	0xC0	Flag
1	0x02	–
1	0x13	Control
1	0x00	Status (reserved)
1	–	Command code (see below)
1	0x00	–
2	–	CRC
1	0xC1	Flag

- Following commands are used for downloading "Event Log" from syringe pump to computer:

CODE	DESCRIPTION
0x01	Send Model and SN
0x30	Send Event Log Size
0x31	Send (repeat) frame
0x32	Send next frame
0x33	Quit

- Following format is used for transferring data from syringe pump to computer:

BYTES	CODE	DESCRIPTION
1	0xC0	Flag
1	0x03	–
1	0x13	Control
1	0x00	Status (reserved)
1	–	Code of command from PC pump is responding to
1	0x00	–
45	–	Data (5 events)
2	–	CRC
1	0xC1	Flag

◆ Technical specification of the RS232 Interface is shown in the 1 table

1 table

RS 232 Specification	
Connector	9-pin D-Socket
TX	Pin 3
RX	Pin 2
Baud rate	9600 baud
Bit format	1 start, 8 data, no parity, 1 stop
Character format	Binary/ASCII (see below)
Ground	Pin 5
Isolation socket/pump	4 kV, Air Gap ±15kV, Contact ±8kV

NOTE:

ASCII is used to transfer information regarding pump model in response to command “Send Model and SN”

◆ Cable connections scheme is shown in 2 table

2 table

PC	Pump
Pin 3 (Tx)	Pin 2 (Rx)
Pin 2 (Rx)	Pin 3 (Tx)
Pin 5 (Ground)	Pin 5 (GND)
Pin 4 Nc	Pin 4, Pin 7 (Jumper)
Pin 7 Nc	